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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
B62D 1/02, 15/00

A1

(11) International Publication Number: WO 98/21081

(43) International Publication Date: 22 May 1998 (22.05.98)

(21) International Application Number: PCT/GB97/03040

(22) International Filing Date: 5 November 1997 (05.11.97)

(30) Priority Data:
9623396.0 8 November 1996 (08.11.96) GB
9626717.4 23 December 1996 (23.12.96) GB

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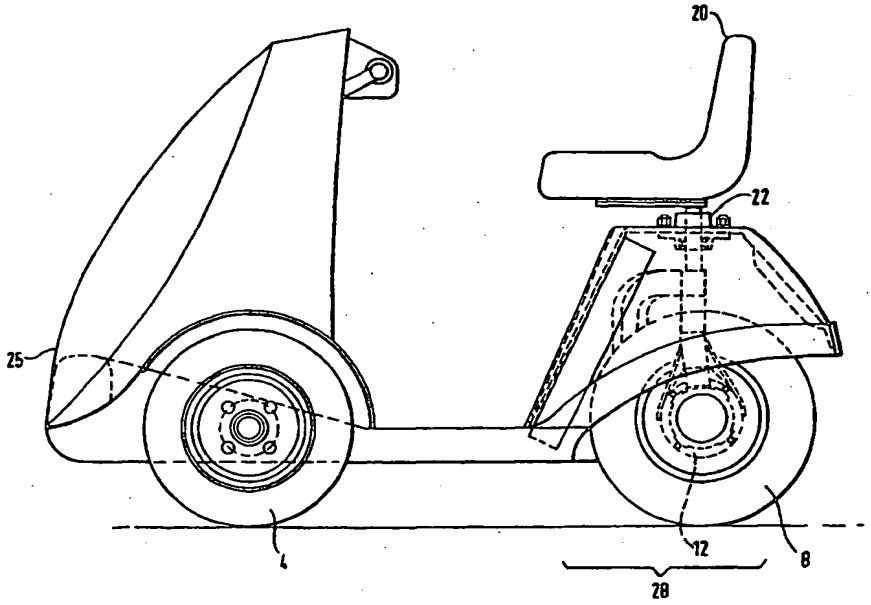
(81) Designated States: AU, CA, JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: A VEHICLE



(57) Abstract

A steering mechanism is provided for a vehicle in which the driver's seat (20) is rotatable about a control axis in order to steer the vehicle.

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A VEHICLE

The present invention relates to a vehicle.

Conventional wheeled vehicles, such as automobiles, typically employ front wheel steering mechanisms. This tends to limit the manoeuvrability of the vehicle due to the limited amount by which the wheels can be turned away from the straight-ahead direction. This limitation is generally acceptable for cars and other high speed vehicles used on the public highway, but is less acceptable for vehicles used as sports vehicles, carriages for conveying the elderly or infirm, or on vehicles adapted to carry loads in confined spaces, such as warehouses.

According to a first aspect of the present invention, there is provided a steering mechanism for a vehicle, comprising a direction control element which is controlled in response to rotation of a driver support member about a control axis.

Preferably the direction control element comprises a wheel or wheels rotatably mounted about a first axis to vary the direction of travel.

The wheel may be carried on a wheel support having a substantially inverted "L" or inverted "U" shape. The upper portion of the wheel support is rotatably coupled to a vehicle chassis or frame in order to turn about a substantially vertical axis to provide steering control.

The substantially vertical axis corresponds to the first axis and could be inclined slightly in a direction along the longitudinal axis of the vehicle in order to vary the steering characteristics, for example to improve the tendency of the vehicle to travel in the straight ahead direction.

Additionally or alternatively, a damping device, such as a friction element, may be provided to increase the force required to turn the steering wheel about the first axis. This dampens the steering and thereby prevents the vehicle form exhibiting oscillatory changes of direction.

Preferably the wheel is driven by a motor. An electric motor may be held on the wheel support and coupled to the wheel via a gearbox.

Preferably, the driver support member is a driver's seat. It is thus possible to provide a vehicle which is steered by rotating the driver's seat about a control axis.

Advantageously, the control axis is substantially vertical.

Alternatively, the direction control element may be a rotating sphere which, in use, makes contact with a surface over which the vehicle is travelling.

Preferably, the sphere is held captive within a cage and arranged such that part of the sphere projects from the cage to engage a surface adjacent the vehicle, and a drive roller

engages the sphere to cause the sphere to rotate, the drive roller being rotatably mounted about a first axis to the vary the direction of drive.

It is thus possible to provide a drive mechanism in which the driving force can be readily controlled to act in any chosen direction.

According to a second aspect of the present invention, there is provided a vehicle having a steering mechanism according to the first aspect of the present invention.

Advantageously, the vehicle has three points of contact with the ground. The sphere or wheel of the steering and drive mechanism constitutes a first point of contact, whereas first and second wheels may provide the additional points of contact. The first and second wheels may be mounted for rotation about a common axis. The first and second wheels may constitute the forward points of contact with the ground, whereas the sphere or wheel of the steering and drive mechanism may form a rear point of contact. Alternatively, this configuration may be reversed such that the sphere or wheel of the steering and drive mechanism forms the forward most contact and the first and second wheels form the rearmost regions of contact with the ground.

Advantageously, in the case of a vehicle having a driven sphere, the drive roller is positioned slightly forwardly of the uppermost point of the sphere. This has the advantage that, whilst the vehicle is travelling in the forward direction, the drive roller is urged to climb towards the top of the sphere. This ensures good frictional contact between the roller and the sphere and partially or wholly balances the forces acting on a

guidance system for the sphere.

Preferably, the first axis is substantially perpendicular to the surface over which the vehicle travels. Thus, (assuming the vehicle is on a horizontal surface) the drive roller is driven about a horizontal axis in order to impart drive to the sphere, but is also rotatable about a substantially vertical axis, in order to vary the direction of drive. Turning the drive roller from the "forward" driving position, causes the roller to be forced more firmly into contact with the sphere. This additional contact is taken up by further deformation of the sphere. The roller is turned about the vertical axis in response to movement of the driver support member.

The drive roller may incorporate an integral electric motor. This provides a compact drive design. However, such an arrangement can give rise to heat dissipation problems, and vehicles designed to carry heavy loads or move relatively fast may have one or more motors located adjacent the drive roller. Such electrically driven vehicles are suitable for use as invalid carriages or as the moving platform for fork-lifts or other low speed applications. More speedy vehicles for sports use, leisure use, or crossing rough or difficult terrain, may be powered by internal combustion engines.

Preferably, the sphere is resiliently deformable. The sphere may comprise a hardened rubber shell incorporating a plurality of circular reinforcement bands. The sphere may be filled with compressed gas. During the prototyping of the present invention, a basket-ball adequately fulfilled the role of the sphere.

Advantageously, the sphere is held at a predetermined position within its cage. Three or more ball supports may be used to keep the sphere in position. Each ball support may comprise a sphere held within a cup by a plurality of recirculating ball-bearings. Alternatively, a series of rollers may be positioned around the sphere, or a retaining ring of low friction material may be provided. This provides a robust inexpensive arrangement for holding the sphere in position.

When the steering is performed from the rear of the vehicle, it may be advantageous to reverse the direction in which the steering wheel or roller is turned about the steering axis compared to the motion of the driver support member, in order to provide intuitive steering. In an embodiment of the present invention in which the seat is rotated around a support axis to provide steering, if the seat is rotated anticlockwise in order to turn the vehicle to the left, the steering wheel or roller may be rotated clockwise about its steering axis in order to effect a left turn. The reversal of motion can be performed by a suitable gearing arrangement.

Alternatively, the seat may be directly coupled (i.e. the sense of rotation is not reversed) to the steering wheel or roller to provide steering.

Advantageously, a non-linear gearing arrangement may be used to connect the driver support member to the direction control element. The non-linear gearing arrangement may, for example. comprise an elliptical gear or a pivot arm assembly. Alternatively, the position of the direction control element may be measured and processed to control

actuators controlling the direction control element. Thus, the steering may be arranged to provide fine directional control when the vehicle is travelling substantially straight ahead, but provide proportionally greater steering for a given angular rotation of the driver support member as the steering angle increases from the straight ahead direction.

Preferably, the vehicle has balance weights located adjacent the first and second wheels in order to prevent the vehicle from toppling when the driver mounts or dismounts, or turns violently. In the case of an electrically powered vehicle, the batteries may be located adjacent to the front wheels and serve as the balance weights.

Advantageously, the first and second wheels may also be driven to provide a high tractive effort variant.

Advantageously, the vehicle may include a towing socket for connection to a tow hitch of a towing vehicle. The towing socket is advantageously located at the end of the vehicle nearest to the drive sphere or drive roller. The height of the towing socket is selected such that, during towing, the drive sphere or drive roller is lifted out of contact with the ground.

According to a third aspect of the present invention, there is provided a drive mechanism for a vehicle, the drive mechanism comprising a sphere held captive within a cage and arranged such that part of the sphere projects from the cage to engage a surface adjacent the vehicle, and a drive roller engaging the sphere to cause the sphere to rotate, the drive

roller being rotatably mounted about a first axis to the vary the direction of drive.

According to a fourth aspect of the present invention, there is provided a self-propelled vehicle adapted to be towed by another vehicle.

Preferably, during towing, the direction control element (such as a drive wheel or drive sphere) is lifted out of contact with the surface over which the vehicle is being towed. The vehicle may have a tow socket for connection to a tow hitch, for example, a tow ball, of another vehicle.

The present invention will further be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a vehicle constituting a first embodiment of the present invention;

Figure 1A is a view from behind the vehicle along the direction of arrow A showing the rear wheel and wheel support;

Figure 2 is a side view of the vehicle shown in Figure 1, and showing some of the hidden details adjacent the steering wheel;

Figure 3 is a view of the front of the vehicle shown in Figure 2;

Figure 4 is a schematic view of a front wheel;

Figure 5 is a plan view of a vehicle constituting second embodiment of the present invention;

Figure 6 is a schematic cross-section of the vehicle shown in Figure 5; and

Figure 7 illustrates the drive arrangement in greater detail.

The vehicle shown in Figure 1 comprises a chassis 2 which supports first and second wheels 4 and 6 at the front thereof, and a single steering and drive wheel 8 at the rear thereof. The steering wheel 8 is mounted on a wheel support bracket 10, which is substantially "L" shaped as shown in Figure 1A. An electric motor 12 and gearbox 14 are secured to the bracket 10 in order to drive the wheel 8. The uppermost portion of the bracket 10 is attached to a shaft 15 which extends towards, and connects with, a passenger seat 20. The shaft 15 is held by a journal bearing 22 to the chassis 15 thereby enabling the shaft 15 to rotate about its axis but holding it against longitudinal motion. Thus the steering wheel 8 can be rotated by the user rotating the seat 20 about the axis of the shaft 15.

In order to provide a chassis that is both light and rigid, the chassis comprises a peripheral metal frame which effectively defines the edges of the floor pan of the vehicle. The upper and lower surfaces of the floor pan are constituted by moulded plastic elements, and the space between the plastic elements is filled with a structural foam. This provides a chassis

which is both light and strong, and which also enables structures, such as a fairing 25, and a rear pod 28 comprising a frame supporting the seat 20 and the drive wheel 8 and associated motor and gearbox, to be easily bolted to the chassis. This facilitates maintenance, repair or modification of the vehicle.

The forward most part of the chassis has a pipe 30 extending through the space defined by the upper and lower plastics layers 32 and 34 and the integral structural foam 36. As shown more clearly in Figure 4, the pipe 30 provides the support for stub axles 38 which hold the front wheels 4 and 6. The stub axle 38 is supported on bushes 40 and 42. A support plate 44 is secured to the stub axle 38 and also to the chassis 2, thereby holding the axle 38 against rotation or translation within the tube 30. The outermost end of the stub axle engages with a wheel bearing which supports the front wheel 4.

Batteries, for example of the lead acid type are held in a battery recess located towards the front of the vehicle. In use, a cover is provided above the batteries in order to prevent them being damaged by the user of the vehicle.

The degree of rotation of the steering wheel 8 about its shaft 22 may be limited by stops (not shown) to prevent the vehicle performing too tight a turn. The space beneath the seat 20 may be used to house power electronics which control the motor speed. Motor speed controllers are known per se, and need not be described here.

An alternative embodiment of the vehicle will now be described.

The vehicle shown in Figure 5 comprises a chassis 2 which supports first and second wheels 4 and 6 at a front end 108 thereof. A sphere 110 held within a cage, indicated generally as 112, provides the rearmost support of the vehicle. A tow socket 113 is also provided at the rear end of the vehicle to enable the vehicle to be attached to the tow ball of a car and towed.

A drive roller 114 is disposed above the sphere 110 and located slightly forward of the centre of the sphere, as shown in Figures 5 and 6. The roller 114 is in contact with the sphere and is driven about a horizontal axis indicated as chain line 116 in order to rotate the sphere, and thereby to drive the vehicle. The roller 114 is also carried on a vertical shaft 118 which is rotatable about its own axis, so as to control the direction in which the sphere 110 is driven.

The sphere 110 is also held in position by supports 120. Each of these comprises a ball held within a supporting cup. The ball is supported within the cup on a plurality of recirculating bearings. This enables the ball to rotate in any direction in order that it can take up the motion of the sphere 110.

The drive roller 114 contains an integral electric motor which receives power from batteries 122 via a direction control switch, a speed regulator (not shown) and slip rings. The batteries 122 are, as with the first embodiment, positioned adjacent the first and second wheels 4 and 6 so as to balance the vehicle against toppling when the driver mounts or dismounts, or turns his seat away from the central position.

As shown in Figure 7, the drive roller 114 is offset in a forward direction from the centre 124 of the sphere 110. The angle between a vertical line passing through the centre of the sphere 124 and a plane 126 containing the axis of rotation of the drive roller 114 and also passing through the centre of the sphere, is typically between 3° and 20°. Forces resisting the rotation of the sphere 110 cause the sphere to try to move to a position beneath the roller 114. This causes the force acting between the sphere and the roller to increase, thereby enabling the maximum driving torque to be increased.

The driver's chair 132 is connected to an input shaft 130 of a differential gearbox 134. Such an arrangement allows the chair and the support shaft 118 to be arranged in line with one another whilst reversing the sense of the turn such that anticlockwise motion of the chair 132 about its support causes the roller 114 to be rotated in a clockwise motion about the support 118.

The vehicle may be fitted with a fairing 140 in order to provide a personal transport. Alternatively, the fairing 140 may be omitted and the front most portion of the vehicle may be fitted with forklifts, thereby enabling it to be used to transport goods within a warehouse.

In an alternative arrangement, the shaft 118 may be rotated by an electric motor acting through a gearbox.

When it is desired to transport the vehicle to another location, the rear end of the vehicle is coupled to a two ball of a towing vehicle via the towing socket 113. The socket 113

may be of the conventional cup-type commonly found on light trailers. During towing, the wheels 4 and 6 remain in contact with the surface beneath the vehicle, but the drive sphere 110 is lifted out of contact with the surface. Thus, the vehicle can be towed for many miles in this configuration.

In each of the embodiments, the fairing may serve to define not only a passenger space, but also a load space. For example, the front of the fairing may be provided with an internal net which acts as a shopping carrier. The first embodiment of the invention may also be provided with a towing hook in order to facilitate transport over large distances.

The excellent manoeuvrability of the vehicle makes is especially suited for use in confined spaces, but also enables it to be used for recreational pursuits.

CLAIMS

1. A steering mechanism for a vehicle, characterised by a direction control element (8,110) which is controlled in response to rotation of a driver support member (20, 132) about a control axis.

2. A steering mechanism as claimed in claim 1, characterised in that the direction control element is a wheel (8).

3. A steering mechanism as claimed in claim 2, characterised in that the wheel is rotatably carried on a wheel support (10), and the support (10) is rotatable about a first axis.

4. A steering mechanism as claimed in claim 3, characterised by a damping device is provided to dampen rotation of the wheel support (10) about a first axis.

5. A steering mechanism as claimed in any one of claims 2 to 4, further comprising a motor drivingly coupled to the wheel (8).

6. A steering mechanism as claimed in claim 3, characterised in that the first axis is inclined along a longitudinal axis of the vehicle.

7. A steering mechanism as claimed in claim 1, characterised in that direction control element is a sphere (132) held captive within a cage and arranged such that part of

the sphere projects from the cage to engage a surface over which the vehicle is travelling, and a drive roller (114) engaging the sphere (132) to cause the sphere to rotate, the drive roller being rotatably mounted about a first axis to vary the direction of the drive.

8. A steering mechanism as claimed in any one of the preceding claims, characterised in that the driver support member is a driver's seat.

9. A steering mechanism as claimed in any one of claims 1 to 8, in which the direction control element is arranged to rotate in an opposite sense to the rotation of the driver support member about the control axis.

10. A steering mechanism as claimed in claim 3, characterised in that the first axis is substantially vertical.

11. A vehicle, including a steering mechanism as claimed in any one of the preceding claims.

12. A vehicle as claimed in claim 11, characterised in that the direction control element is located towards the rear of the vehicle.

13. A vehicle as claimed in claim 12, further comprising a pair of wheels located towards the front of the vehicle, and having a balance mass located adjacent the wheels.

14. A vehicle as claimed in claim 13, in which the balance mass comprises at least one battery for powering the vehicle.

15. A vehicle as claimed in any one of claims 11 to 14, further comprising an attachment for towing the vehicle.

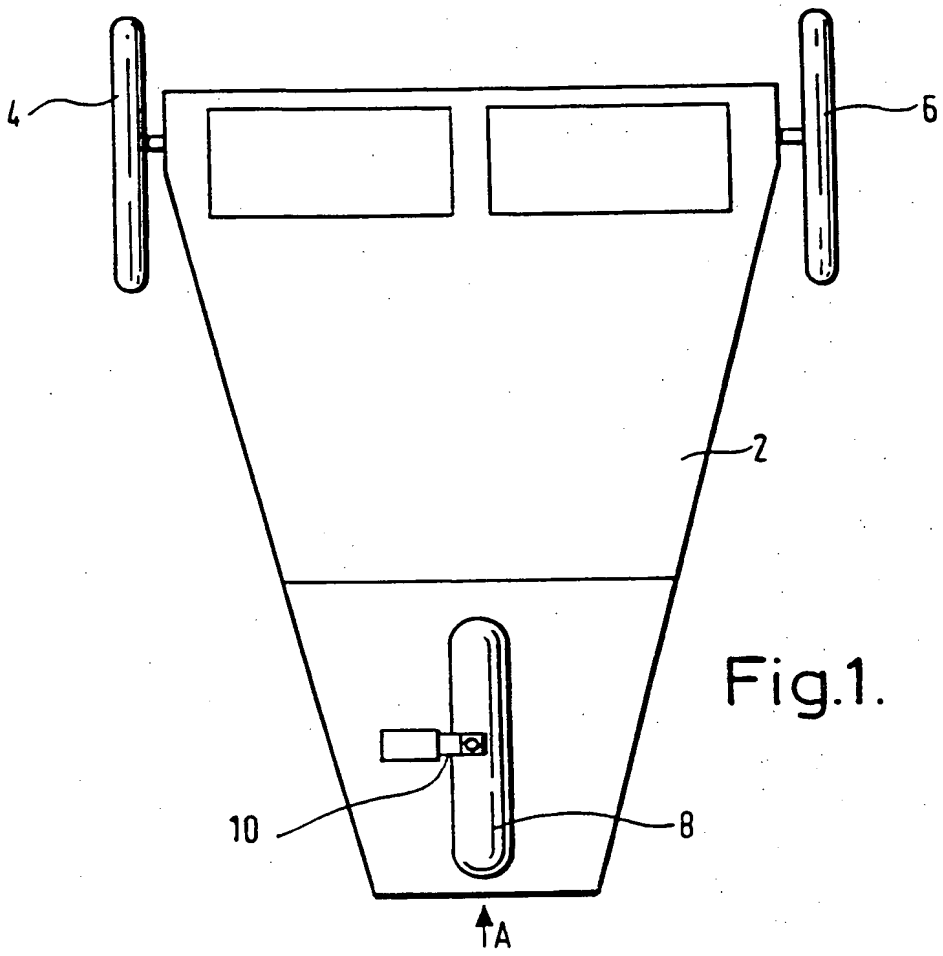
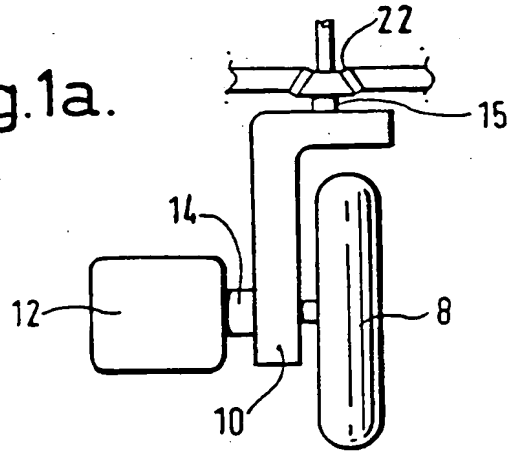


Fig.1.

Fig.1a.



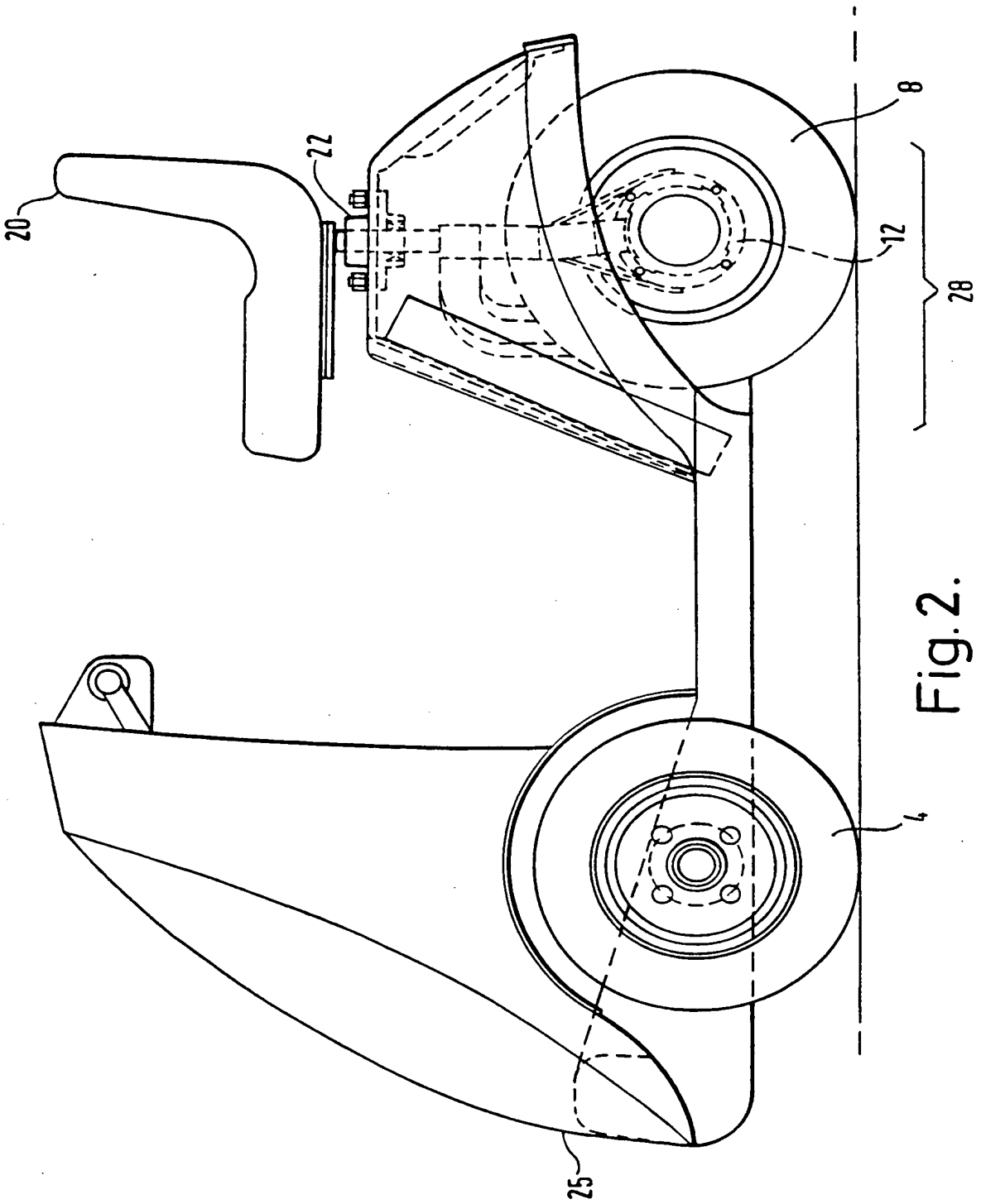


Fig.2.

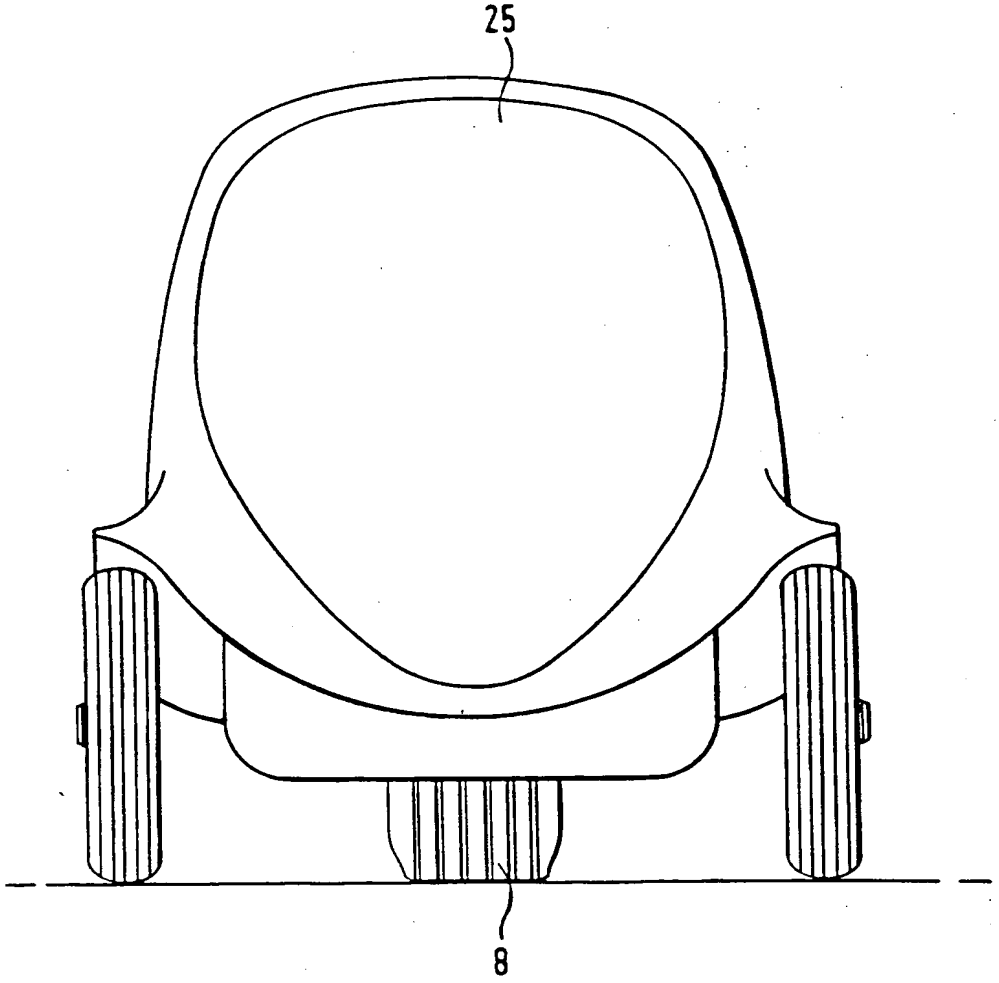


Fig.3.

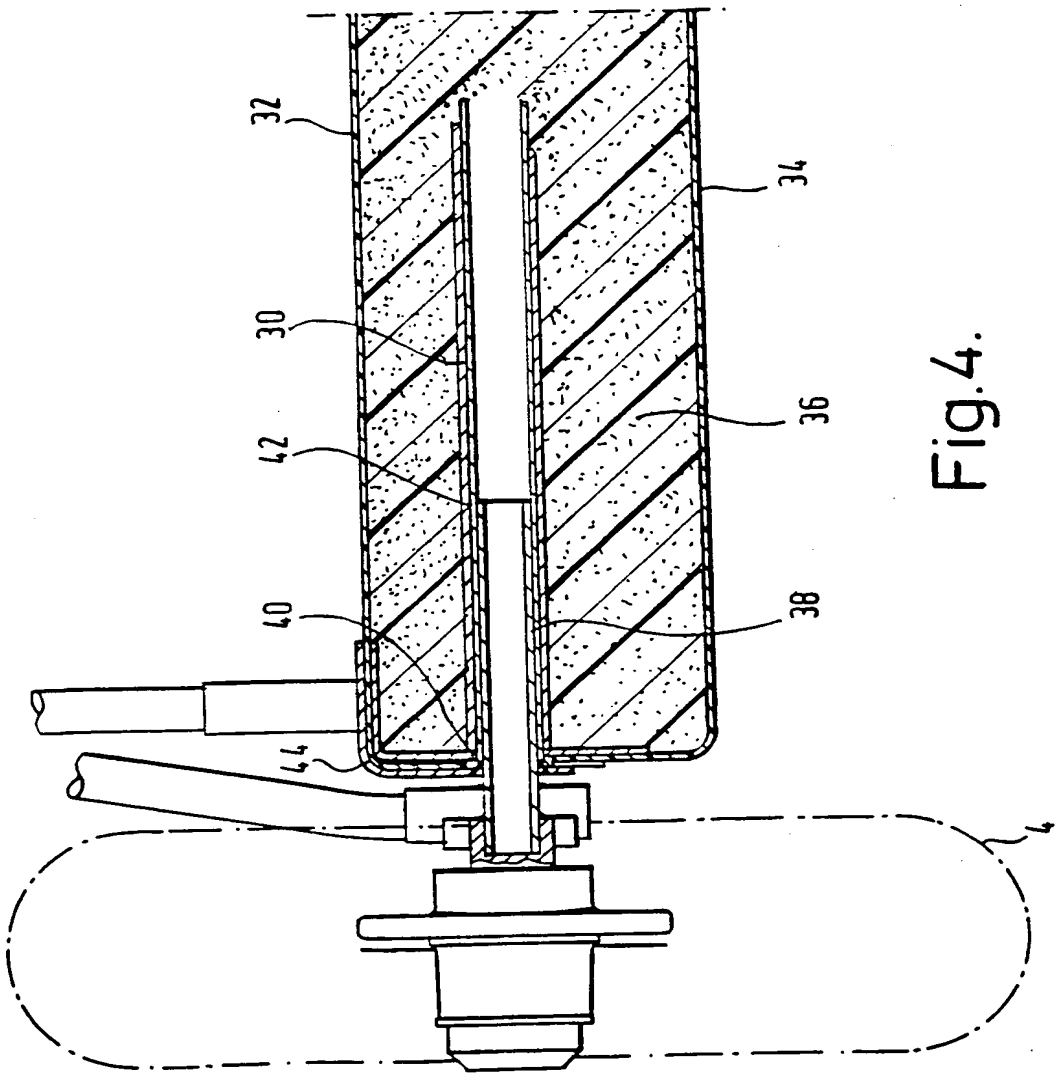


Fig.4.

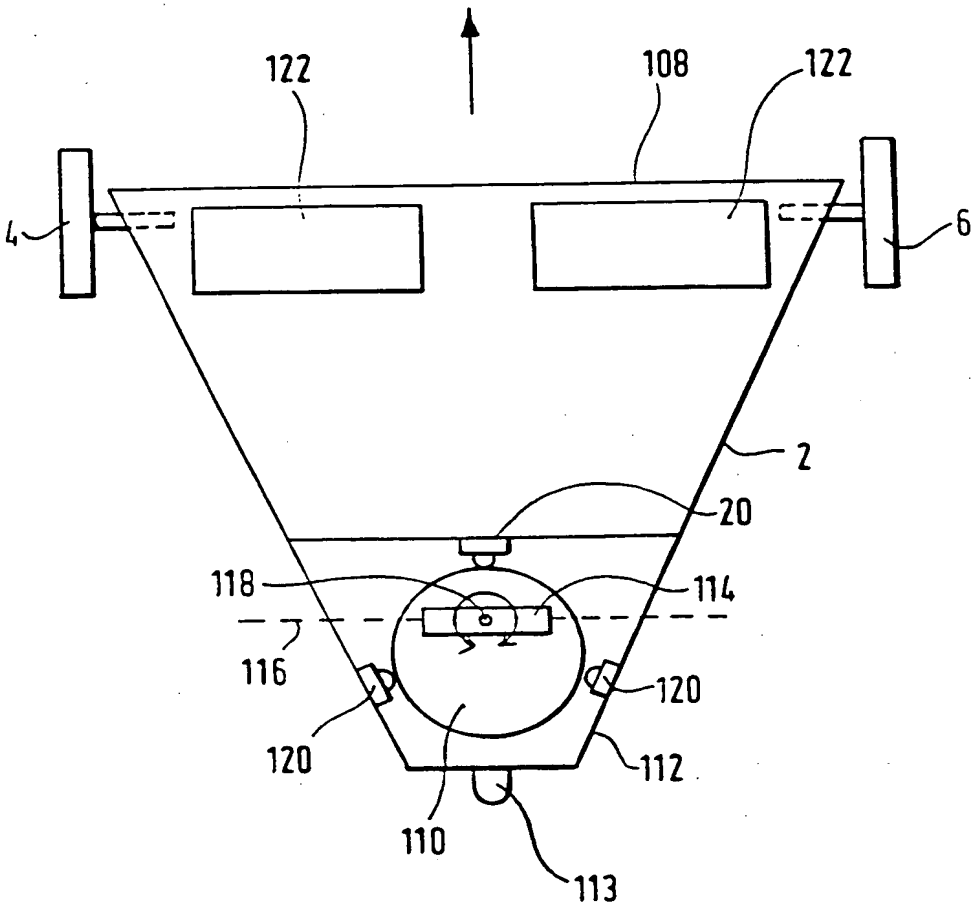


Fig.5.

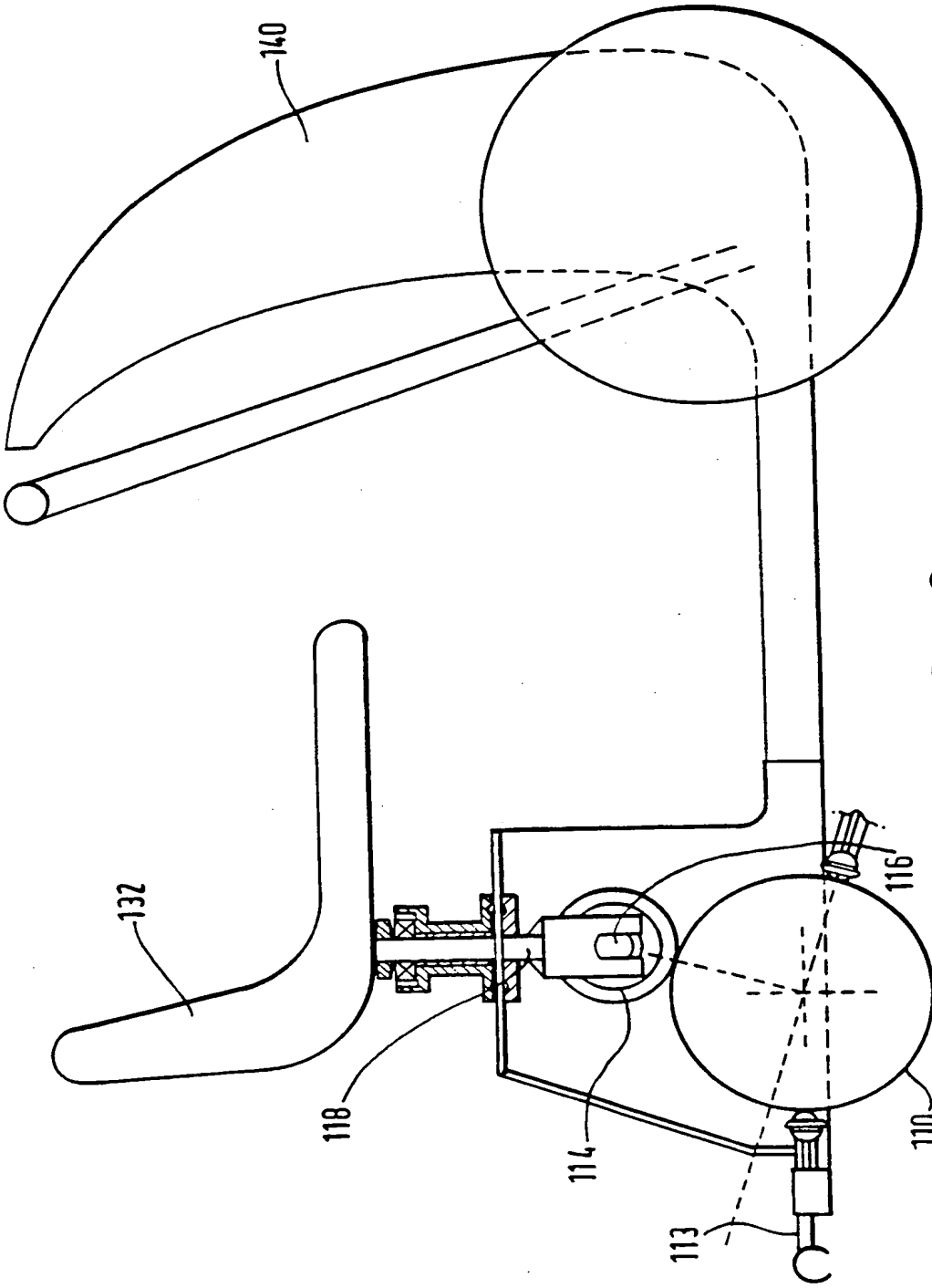


Fig.6.

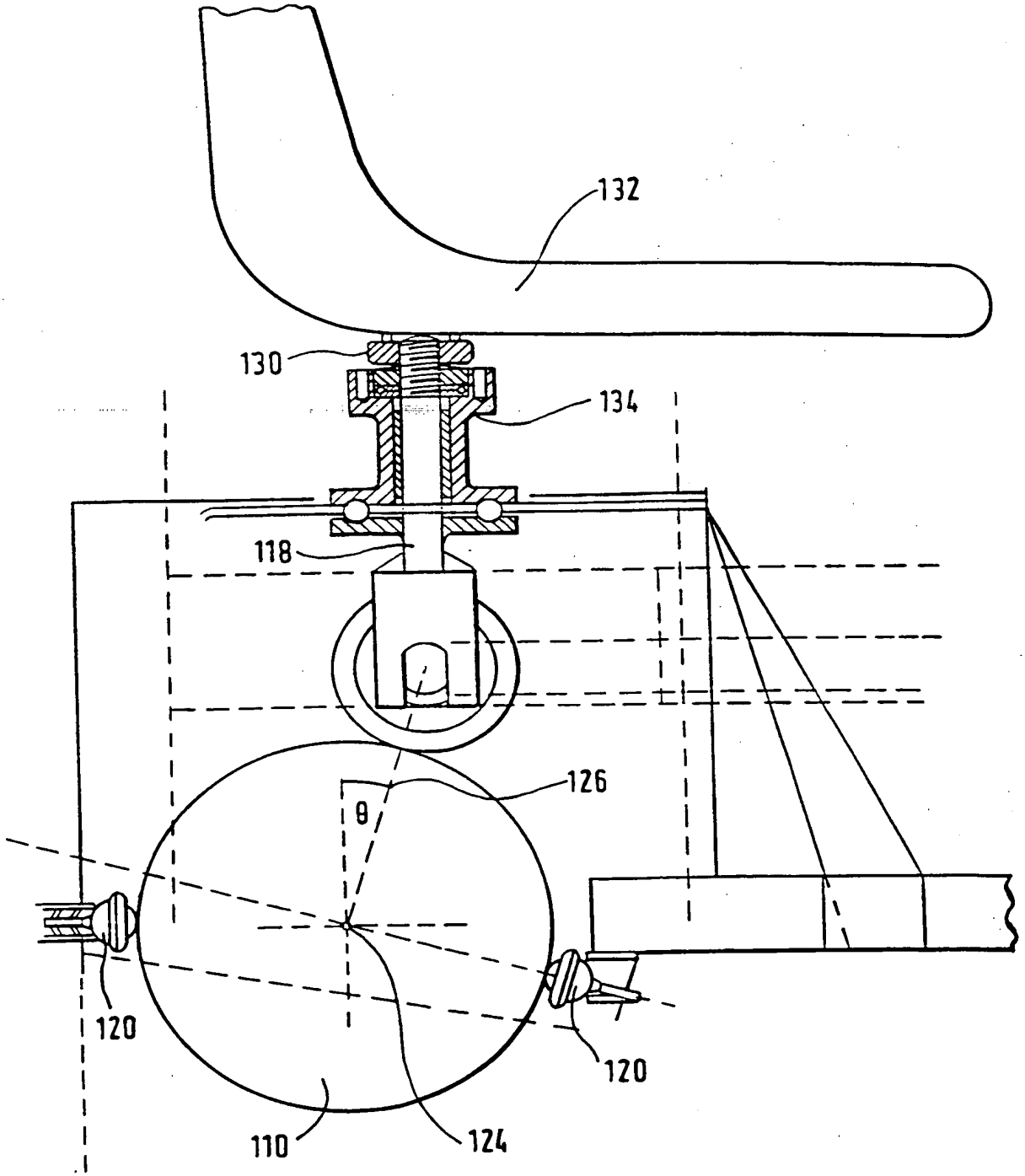


Fig. 7.

INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/GB 97/03040

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B62D1/02 B62D15/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B62D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 014, no. 412 (C-0755), 6 September 1990 & JP 02 156815 A (ISEKI & CO LTD), 15 June 1990, see abstract	1-3,5,8, 10-13
Y	---	7
X	US 4 170 271 A (LOOKER OLIN L) 9 October 1979 see column 3, line 7 - line 52; figures 1-3	1-3,5,6, 9-11
Y	---	7
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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1

Date of the actual completion of the international search	Date of mailing of the international search report
2 February 1998	09/02/1998

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	PATENT ABSTRACTS OF JAPAN vol. 012, no. 057 (M-670), 20 February 1988 & JP 62 203824 A (TOYODA AUTOM LOOM WORKS LTD), 8 September 1987, see abstract	7
P,X	DE 297 10 647 U (ELST PETER DIPL ING FH) 11 September 1997 see page 1, last paragraph - page 2, line 2; claim 3; figure	1-3,8, 10-12
P,Y		7
P,A		13

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. ional Application No
PCT/GB 97/03040

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4170271 A	09-10-79	NONE	
DE 29710647 U	11-09-97	NONE	